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(पहला पुनरीक्षण)

Installation and Observation of Base
Plate Apparatus for Measurement of
Foundation Settlement in
Embankments — Code of Practice
(First Revision)

ICS 93.160

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Hydraulic Structures Instrumentation Sectional Committee had been approved by the Water Resources Division Council.

Foundation settlement (baseplate) apparatus are installed on the foundation under dams and embankments to permit measurements of vertical settlement of the foundation during construction and later during operation. This type of apparatus generally is used where the height of the dam or embankment is relatively low and where the foundation is unconsolidated sand, silt, or clay material. This installation is similar to the cross arm installation for measurement of internal vertical movement in earth dams (*see* IS 7500 : 2000 “Code of practice for installation and observation of cross arms for measurement of internal vertical movement in earth dams (First Revision)”). For the choice and location of instruments in earth dams, reference may be made to IS 7436 (Part 1) : 1993 “Guide for Types of Measurements for Structures in River Valley Projects and Criteria for Choice and Location Of Measuring instruments Part 1 For Earth and Rockfill Dams (First Revision)”. An electrical probe with PVC casing pipe as described in IS 7500 may also be used for the baseplate installation. The pipe system installed for the baseplate system can be usefully utilized for measurement of the water level, if any, at that point.

In the formulation of this standard due weightage has been given to international coordination among the standards and practices prevailing in different countries in addition to relating it to the practices prevailing in this field in this country.

This standard was first published in 1976; however, the Committee responsible for the formulation of this standard decided to revise it based on the experience gained since then as well as considering technological development in the field.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

INSTALLATION AND OBSERVATION OF BASE PLATE APPARATUS FOR MEASUREMENT OF FOUNDATION SETTLEMENT IN EMBANKMENTS — CODE OF PRACTICE (*First Revision*)

1 SCOPE

This standard lays down details of installation and observation of baseplate apparatus for observing foundation settlement of dams and embankments resting on soil strata. For the purpose of this standard the word embankment includes earth and rock-fill dams.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
7500 : 2000	Code of practice for installation and observation of cross arms for measurement of internal vertical movement in earth dams (<i>first revision</i>)
7436 (Part 1) : 1993	Guide for types of measurements for structures in river valley projects and criteria for choice and location of measuring instruments: Part 1 for earth and rockfill dams (<i>first revision</i>)

3 EQUIPMENT**3.1 Components of Installation**

3.1.1 The foundation settlement apparatus consists of a baseplate placed on the foundation excavation line and a vertical column of steel pipes (*see* Fig. 1). The apparatus comprises a base section of 50 mm steel pipe, a cross arm measuring unit (baseplate), and anchor crossarm and an extension of 50 mm pipes to the surface of the embankment.

3.1.2 Base Section

The base section is made of two pieces of 50 mm pipe,

one 600 mm long and one 1 500 mm long, joined by a pipe coupling. A latching plate (*see* Fig. 2) having 4 drill holes of 18 mm diameter is inserted into the coupling between these two sections of pipes.

3.1.3 Baseplate

The baseplate is a modified crossarm with two 300 × 375 mm steel plates of 5 mm thickness welded to the base of 1 000 mm length of 75 mm channel section. The base-plate unit is bolted and welded to a 40 mm pipe which telescopes between lengths of 50 mm pipe in the system. Settlement readings are taken only on the baseplate measuring point which is the bottom of the 40 mm pipe.

3.1.4 Anchor Crossarm

At 1 150 mm above the elevation of the baseplate, an anchor crossarm is placed to prevent the vertical pipe column from sliding down on the baseplate. The anchor crossarm is a 1 000 mm length of 75 mm channel, bolted and welded to a 1 500 mm length of 50 mm pipe.

3.1.5 Extension Pipe

To complete the installation, 1 500 mm lengths of 50 mm pipe are joined by pipe couplings to extend the column of pipes to the surface of the embankment.

3.2 Equipment for Observation**3.2.1 Measuring Torpedo (*see* Fig. 3)**

Readings of baseplate are taken by lowering from the top of the system a torpedo attached to a steel measuring tape. The torpedo is machined to dimensions from a brass shaft and contains two wings or pawls, which open or close at opening slots and closing slots due to spring action. The maximum dimension of torpedo is at the wings when fully opened and this dimension is less than 50 mm and greater than 40 mm.

3.2.2 Reading Scale and Adapter

The details of reading scale with adapter used for lowering the torpedo are given in Fig. 4.

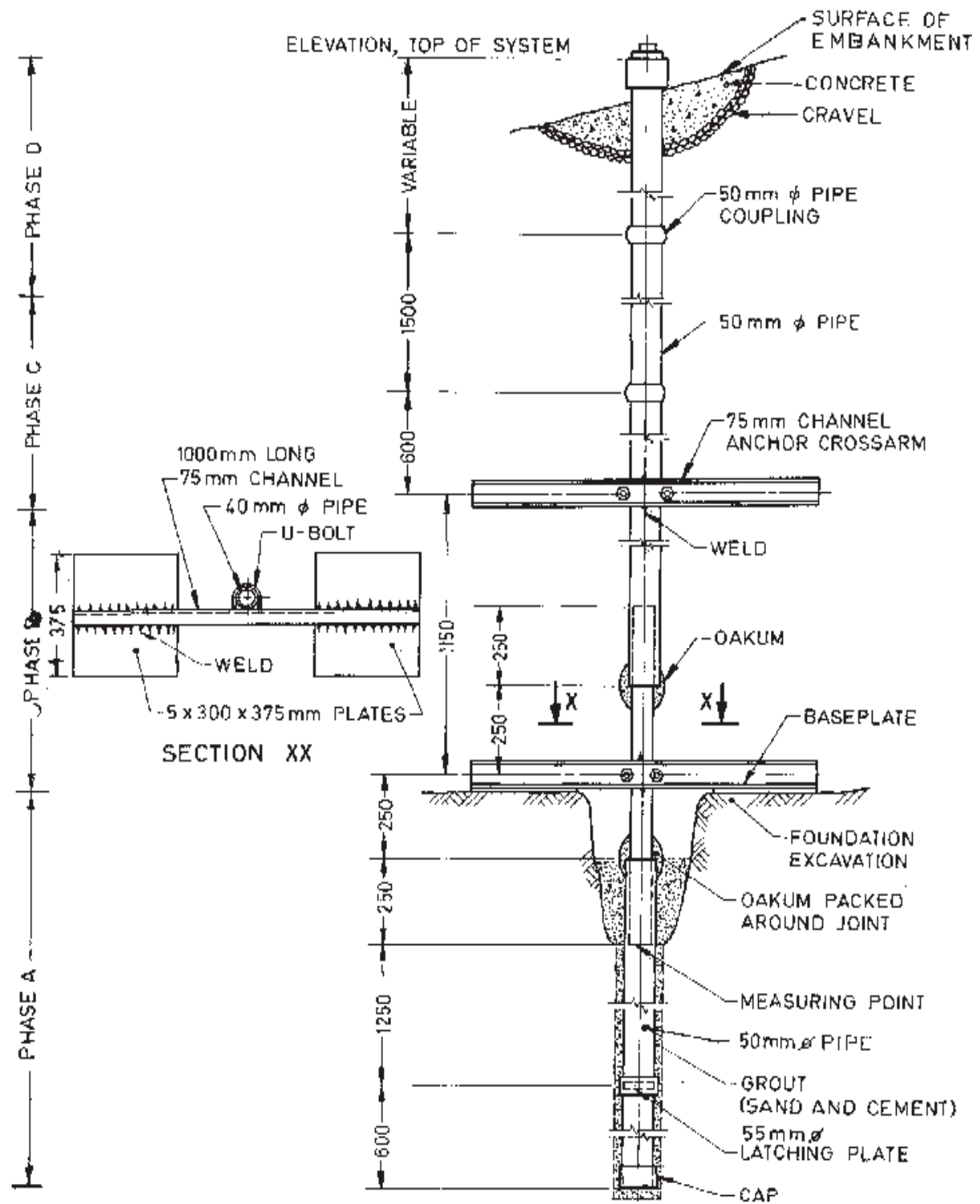
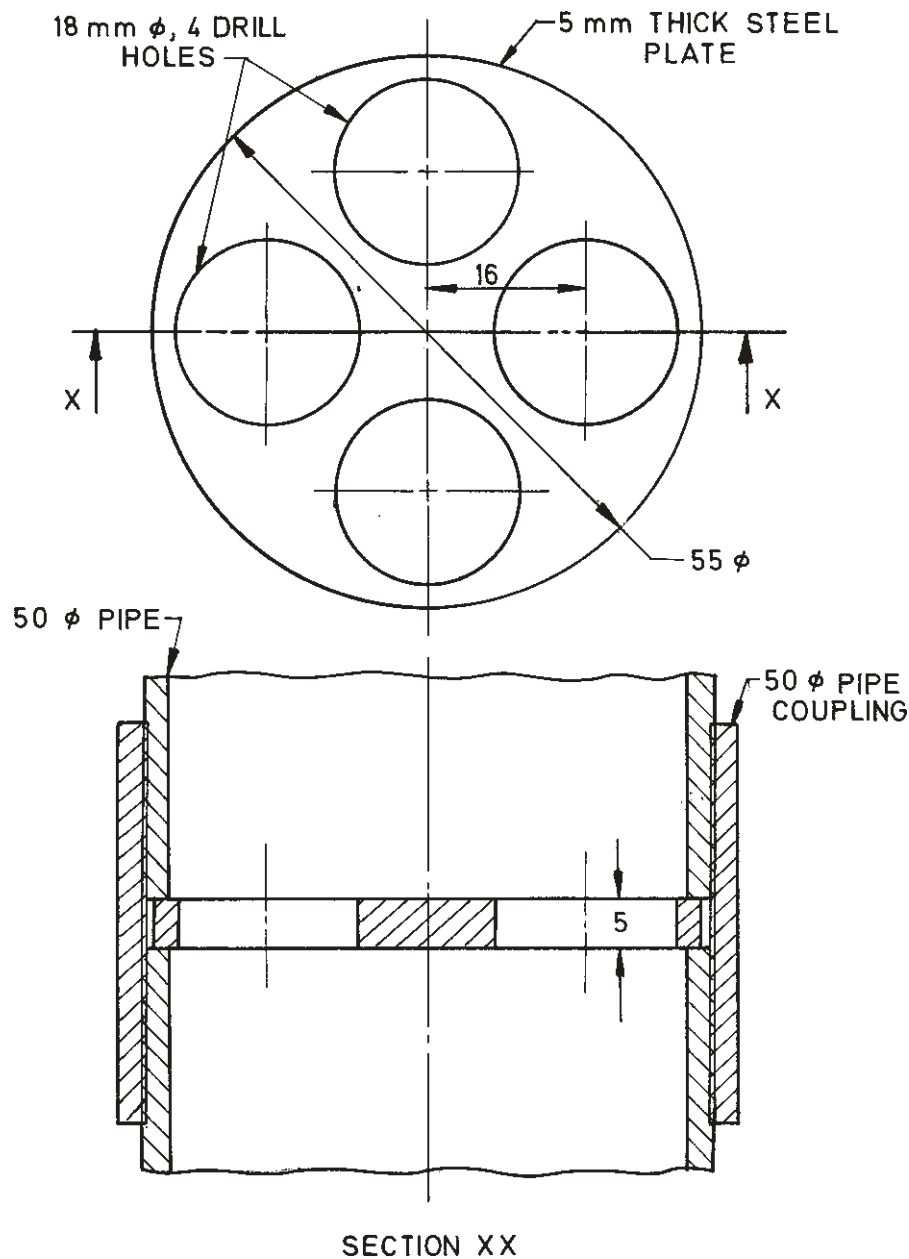


FIG. 1 BASEPLATE APPARATUS



SECTION XX

All dimensions in mm.

FIG. 2 LATCHING PLATE

4 INSTALLATION

4.1 Prior to installation of the test equipment, permanent instrument benchmarks and targets shall be established beyond the area of influence of reservoir and/or embankment load. These targets shall be visible and accessible throughout construction of the entire embankment. These targets and benchmarks are utilized to locate the centre of the installation at all stages of construction.

4.2 Base Extension (see Fig. 5A and 6A)

The centre of installation should be located and level

area of at least 900 mm dia adjacent to centre line of installation at foundation line. A trench should be excavated up to 500 mm below foundation line as shown in the Fig. 5A. The base extension for the device consists of two pieces of pipe which form the extension into the foundation. This extension should be assembled and set into a 100 mm minimum diameter hole which has been drilled to the required depth into the foundation. The hole may be drilled by an earth auger. After placement of the pipe extension, the backfill around the 50 mm pipe should be done with sand and cement grout. If the foundation baseplate is not installed immediately, a temporary removable pipe cover should

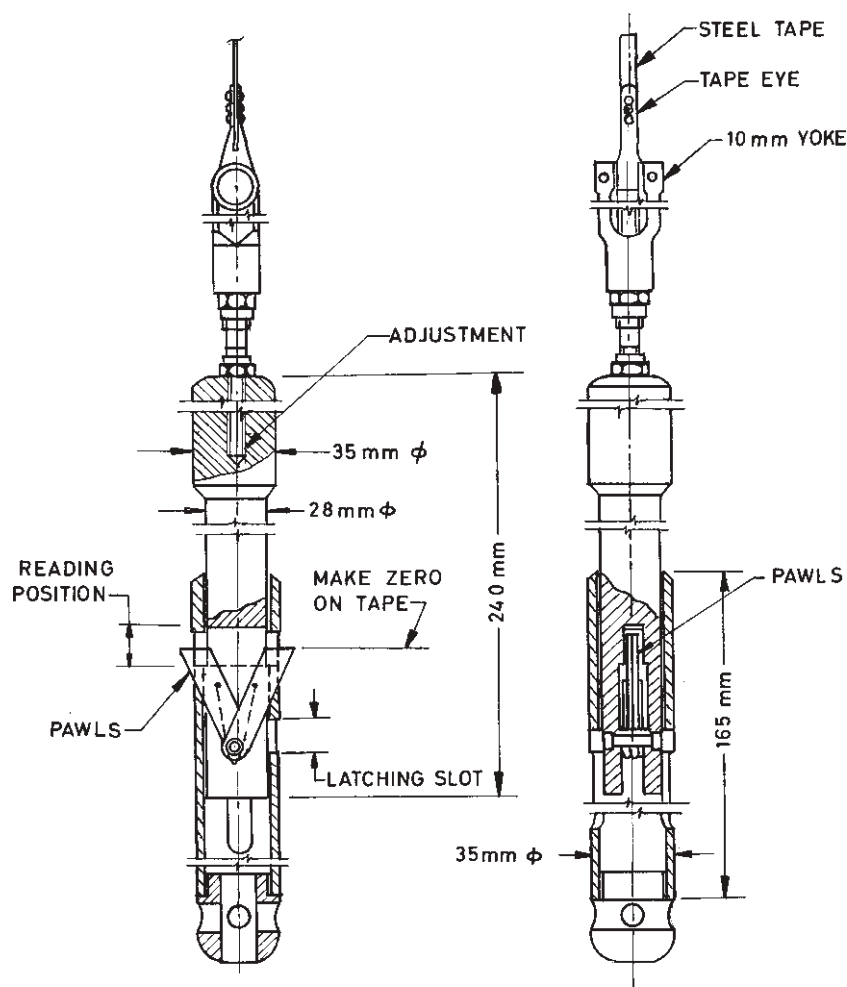


FIG. 3 MEASURING TORPEDO

be placed over the extending 50 mm pipe and backfill with fine soil up to foundation line. Thereafter, compact embankment (450 mm minimum) above installation.

4.3 The foundation settlement apparatus shall be installed as embankment placement operations progress. Each pipe section shall be placed in a vertical position. The operation of all heavy equipment should be prohibited in the immediate vicinity of the installation when sections of the apparatus are being placed. If, for some reason, the upper surface of the embankment in the vicinity of the installation is to be reworked before an additional extension pipe is placed, the installation shall be flagged or marked so that it will not be damaged or displaced by earth moving equipment.

4.4 Installation in Rock-free Soils

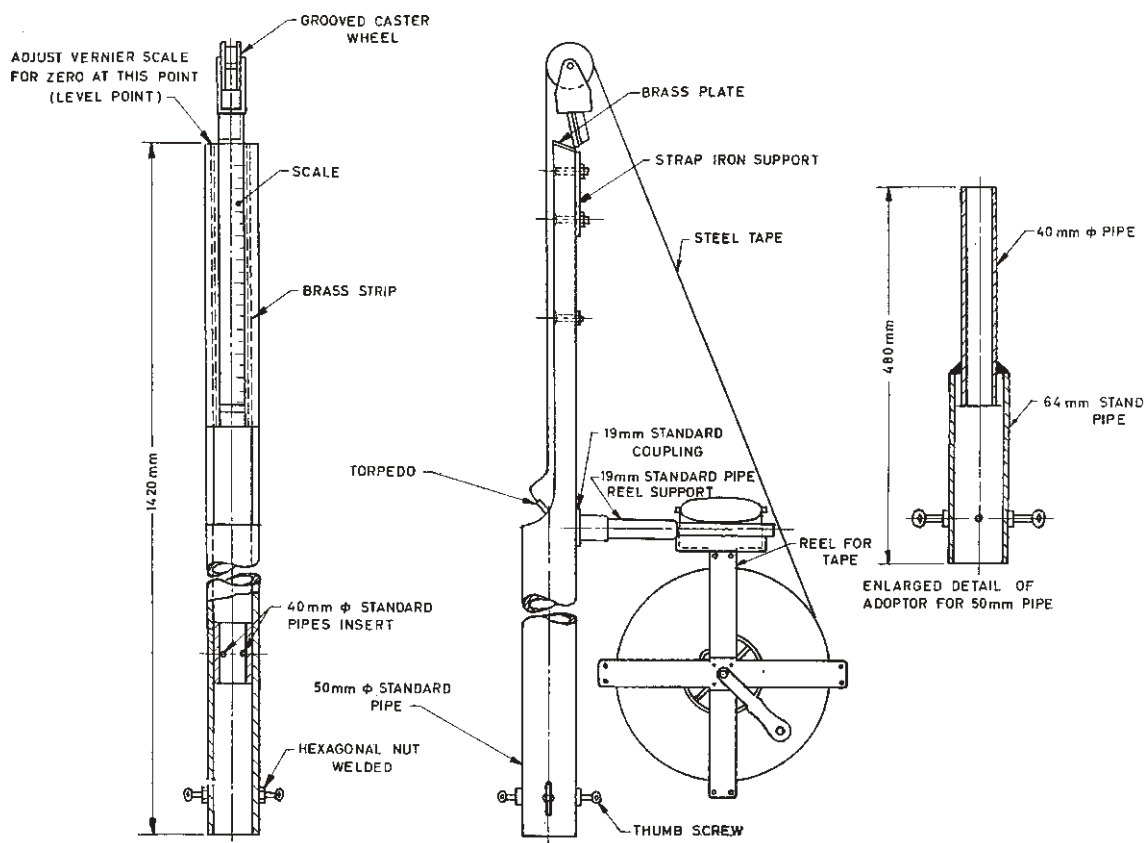
4.4.1 Baseplate (See Fig. 5B)

The centre of installation should be located and a trench excavated up to foundation excavation line. The soil above pipe cover of the base extension should be

removed and the pipe cover also be removed. The baseplate unit should be placed and aligned over the base extension. A pipe cover should be placed on top of the 40 mm pipe of the baseplate unit and the joints of the 40 mm pipe with the base extension pipe at bottom should be fitted with oakum wrapped with burlap. The trench should be backfilled with embankment material to the level of pipe cover at top. The original elevation of the baseplate should be noted by lowering the torpedo in the pipe by removing the temporary pipe cover as described in 5.1 and the pipe cover replaced. The compacted backfilling should then be continued up to the original embankment level. Embankment placement should then be continued.

4.4.2 Extension Pipe and Anchor Crossarm (See Fig. 5C)

The centre of the installation should be located and excavate a trench up to bottom of anchor crossarm. A 200 mm diameter hole should be bored from the bottom of the trench so as to locate the pipe cover placed in operation described in 4.4.1. Remove soil up to 325



NOTES

- 1 Recommend A 15 kg Spring Scale, Hrapple Hook, Tape Clamp Handle and a 10 kg Tension on Tape when taking settlement Readings
- 2 Use device as shown during construction, thereafter cut device to 1120 mm length, and thread bottom end of 50 mm pipe to fit top of installation.

FIG. 4 READING SCALE WITH ADAPTER

mm below top of 40 mm pipe cover as shown. The pipe cover should be removed and the 50 mm pipe with anchor crossarm placed and aligned over the baseplate unit. A pipe cover should be placed on top of the 50 mm pipe and the joints of the 50 mm pipe with the baseplate unit at bottom should be fitted with oakum wrapped with burlap. The trench and borehole should be backfilled with embankment material to the level of pipe cover at top. The elevation of the baseplate should be noted by lowering the torpedo in the pipe by removing the temporary pipe cover as described in 4.1 and the pipe cover replaced. The compacted backfilling should then be continued up to the original embankment level. Embankment placement should then be continued.

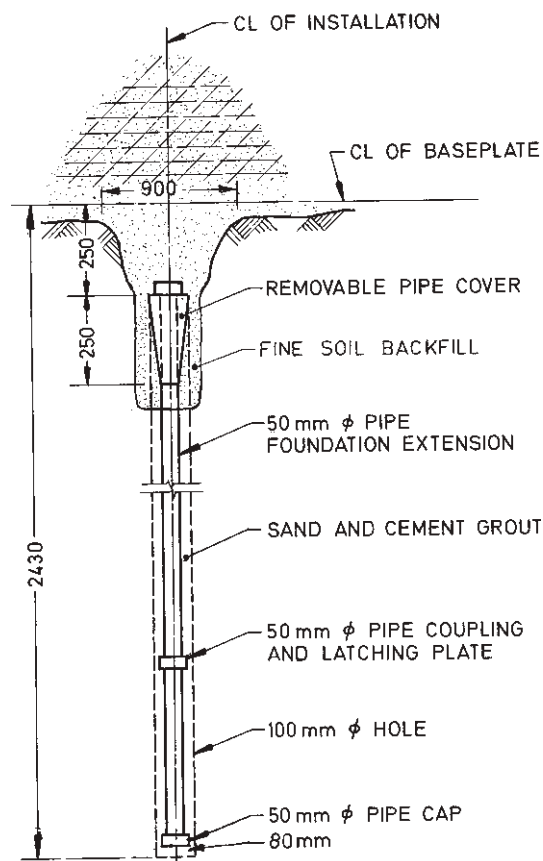
4.4.3 Extension of Pipe to Top of Embankment

For each extension pipe, the operations are similar to those described in 4.4.2 except that no trench is required to be excavated as no cross-arms are installed at higher levels. However cross-arms may be installed at higher elevations so that it becomes a combined foundation

settlement and vertical movement device (see IS 7500). The extension pipes should be placed by using 50 mm pipe couplings till the surface of the embankment is reached. At the surface of the embankment, rocky material should be placed around the pipe extension and concrete placed above so as to afford fixity to the installation (see Fig. 5D). At the top of the last 50 mm pipe a plug should be fitted to a 50 mm coupling.

4.5 Installation in Rocky Materials

4.5.1 It is difficult to bore a hole in rocky material. The operations involved in the installation as described in 4.4.1 to 4.4.3 are therefore modified. The pipe cover over the base extension, if placed should be removed and the baseplate unit should be placed and aligned over the base extension. A pipe cover should be placed on top of the 40 mm pipe of the baseplate unit and the joints of the 40-mm pipe with the base extension pipe at bottom should be fitted with oakum wrapped with burlap. Backfilling should be done to 250 mm above the centre line of baseplate. At this stage, the pipe cover should be removed and the original elevation of



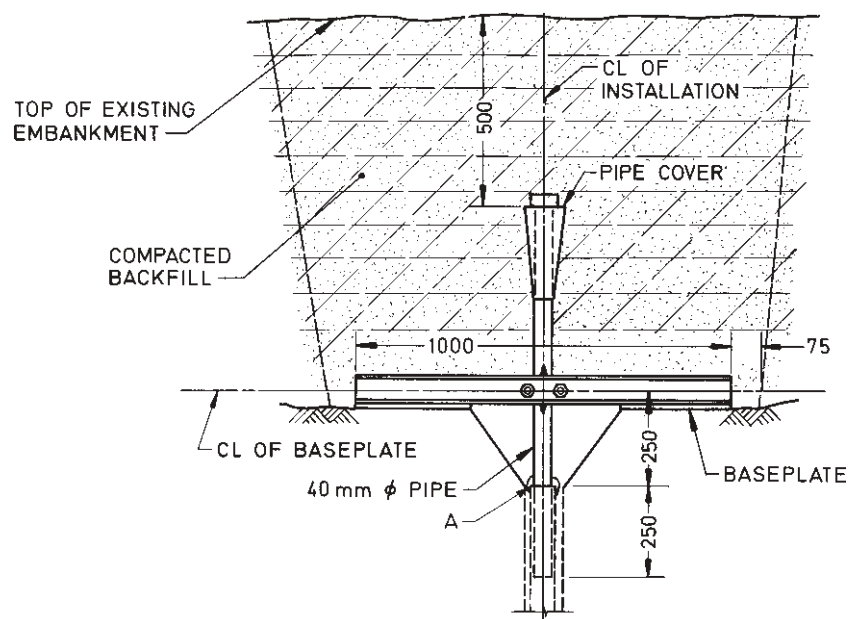
Operations:

1. Locate centre of installation.
2. Level 900 mm dia area adjacent to centre of installation at foundation line.
3. Excavate a trench 500 mm below foundation line as shown.
4. Bore 100 mm minimum dia hole; clean hole.
5. Place and align foundation extension in borehole.
6. Place a removable pipe cover.
7. Place sand-cement grout around pipe, preferably with a tremie, tamp fine soil around cover to foundation line.
8. Compact embankment above installation.

Fig. 5 A Phase 1

baseplate measuring point should be obtained. Then the extension pipe with anchor cross-arm should be placed, aligned and a pipe cover seated at the top of this extension pipe. The joints of the 50 mm pipe with the baseplate unit at bottom should be fitted with oakum wrapped with burlap. A mound of rocky material should be placed around the baseplate pipe and extension pipe to about 75 mm below the pipe cover at the top to support the pipe. The embankment placement around the pipe should be continued till it reaches a level of 150 mm above the pipe cover, leaving a depression around the pipe cover (*see* Fig. 6B). After the anchor cross-arm unit is thus installed, the protective pipe cover should be removed and the vertical alignment of the

system should be checked by lowering a plumb bob. If any deviation from vertical alignment is found, an attempt should be made immediately to correct the error. If it is impracticable to correct the error, succeeding pipe sections should be placed vertically and the offset from the true vertical alignment should be recorded. Succeeding extension pipes should be placed similarly by using 50 mm pipe couplings (*see* Fig. 6C) till the surface of the embankment is reached. At the surface of the embankment, rocky soil should be placed around the pipe extension and concrete should be placed above so as to afford fixity to the installation (*see* Fig. 6D). At the top of the last 50 mm pipe a plug should be fitted to a 50 mm coupling.



Operations:

1. Locate centre of installation.
2. Excavate a trench up to foundation line, remove soil above pipe cover.
3. Remove pipe cover from base extension.
4. Place and align baseplate unit over base extension.
5. Place a removable pipe cover at top of 40 mm pipe.
6. Wrap with oakum and burlap at joints of the 40 mm pipe with base extension (A).
7. Backfill the trench with embankment up to the pipe cover at top.
8. Remove pipe cover at top of 40 mm pipe and obtain original elevation of the baseplate measuring point using torpedo.
9. Place a removable pipe cover at top of 40 mm pipe and compacted backfilling is done up to original embankment level.
10. Continue embankment placing.

Fig. 5 B Phase 2

5 OBSERVATIONS

5.1 Settlement readings shall be taken on the baseplate measuring point which is the bottom of the 40 mm pipe by means of the measuring torpedo shown in Fig. 3. The elevation of the measuring point of the baseplate is determined by lowering the torpedo through the reading scale and into the pipe system by means of the steel tape. Pawls on the torpedo engage the lower end of the 40 mm pipe (the measuring point), and upon reaching the bottom of the installation and striking the latching plate, they latch in a closed position to enable the torpedo to be withdrawn from the system. When readings are made, the reading scale is attached to the top section of the pipe projecting from the existing installation. The elevation of the levelling plate on top of the reading scale shall be established from a permanent benchmark of the embankment.

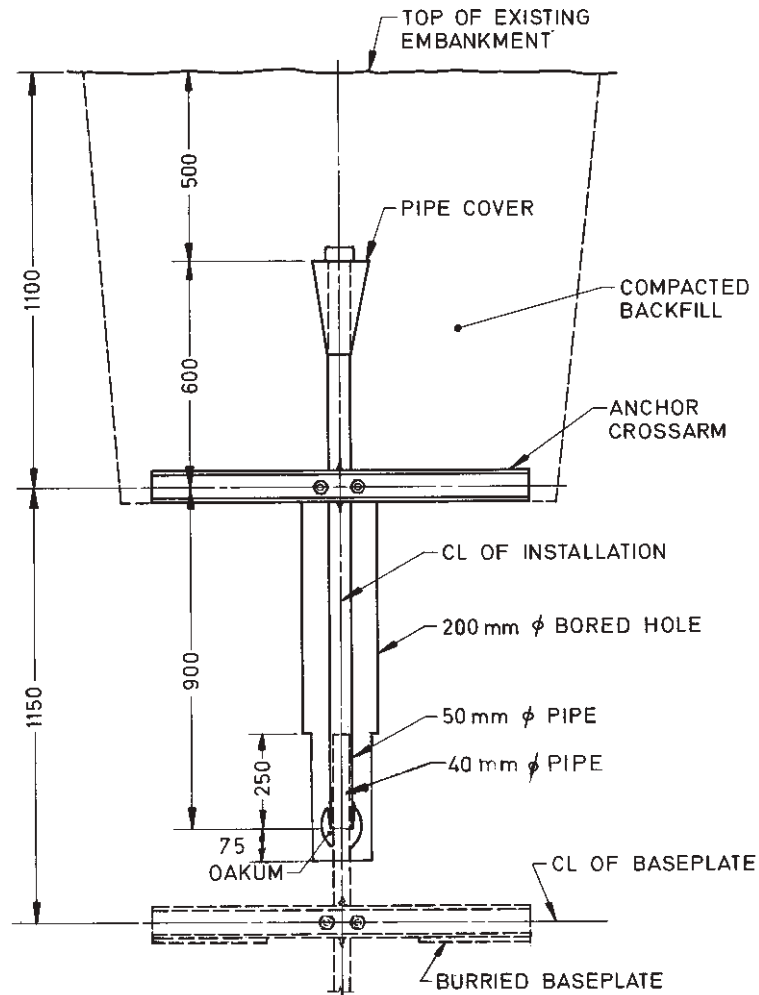
5.2 During construction, readings for elevations of the baseplate measuring points and of the top of the embankment should be determined and noted in the

form given in Annex A. Throughout construction, including shut-downs, readings shall be taken at intervals of 30 day. When the installation is completed the elevation of the top of the final pipe coupling should be established to the nearest 5 mm (*see Note*) and the date of completion should be noted on the form shown in Annex A. The first set of periodic readings should be made immediately after installation; thereafter readings should be taken every 3 months for the first 3 years and every 6 months thereafter. The observations should be recorded in the form given in Annex A.

NOTE — The elevation of the final pipe coupling shall be verified at least once in 6 months with a permanent benchmark.

6 RECORD TESTS

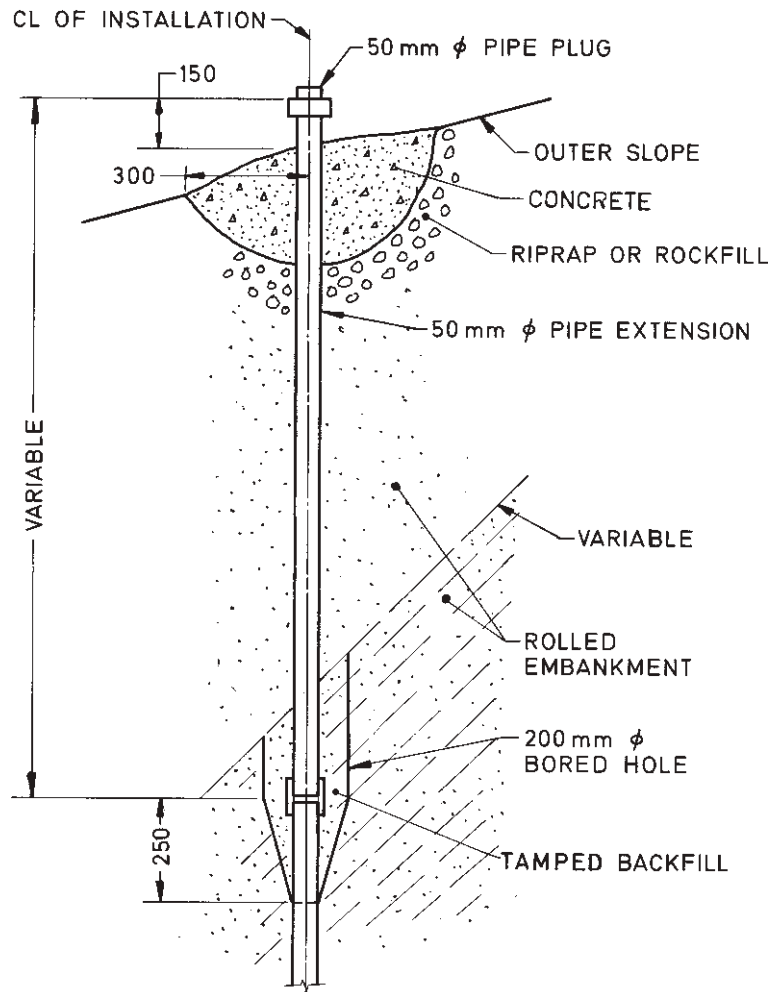
Record tests of foundation materials at the instrument installation are necessary. Representative undisturbed samples of the foundation soils should be obtained and tested for grain size analysis, consistency limits, specific gravity, natural water content, natural dry density and consolidation.



Operations:

1. Locate centre of installation.
2. Excavate a trench up to bottom of anchor crossarm.
3. Bore 200 mm dia hole up to top of 40 mm pipe cover; clean hole.
4. Remove soil up to 325 mm below top of 40 mm pipe cover as shown.
5. Remove pipe cover, place and align 50 mm pipe with anchor crossarm over baseplate unit.
6. Place a removable pipe cover at top of 50 mm pipe.
7. Wrap with oakum and burlap at joints of the 50 mm pipe with baseplate unit.
8. Backfill the trench and borehole with embankment up to the pipe cover at top.
9. Remove pipe cover at top of 50 mm pipe and obtain original elevation of the baseplate measuring point using torpedo.
10. Place a removable pipe cover at top of 50 mm pipe and compacted backfilling is done up to original embankment level.
11. Continue embankment placing.

Fig. 5 C Phase 3



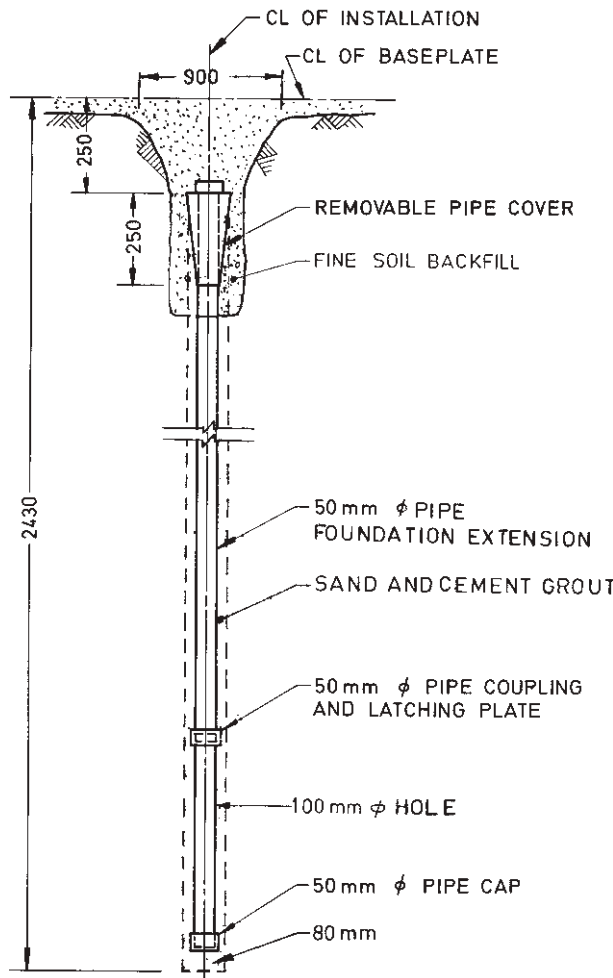
Operations:

1. Locate centre of installation.
2. Bore 200 mm dia hole up to top of 50 mm pipe cover; clean hole.
3. Remove pipe cover, connect 50 mm extension pipe using 50 mm dia pipe coupling.
4. Place a removable pipe cover at top of 50 mm extension pipe.
5. Backfill the borehole with embankment up to the pipe cover at top.
6. Remove pipe cover at top of 50 mm pipe and obtain original elevation of the baseplate measuring point using torpedo.
7. Repeat steps 1 to 6 till the surface of the embankment is reached.
8. Mound rocky material around extension pipe to outer embankment slope.
9. Place concrete above rocky material.
10. Place a plug fitted to a 50 mm coupling at the top of the last extension 50 mm pipe.

Fig. 5 D Phase 4

All dimensions in millimetres

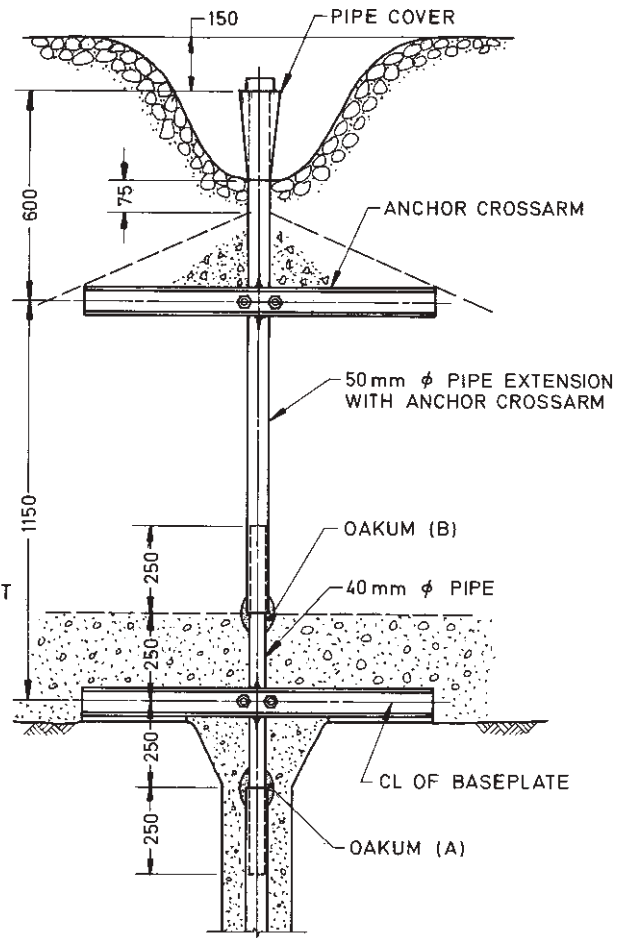
FIG 5 OPERATIONS OF BASEPLATE INSTALATION IN ROCK-FREE SOIL



Operations:

1. Locate centre of installation.
2. Level 900 mm ϕ area adjacent to centre of installation at foundation line.
3. Excavate a trench 500 mm below foundation line as shown.
4. Bore 100 mm minimum ϕ hole; clean hole.
5. Place and align foundation extension in borehole.
6. Place a removable pipe cover.
7. Place sand-cement grout around pipe, preferably with a tremie, tamp fine soil around cover to foundation line.

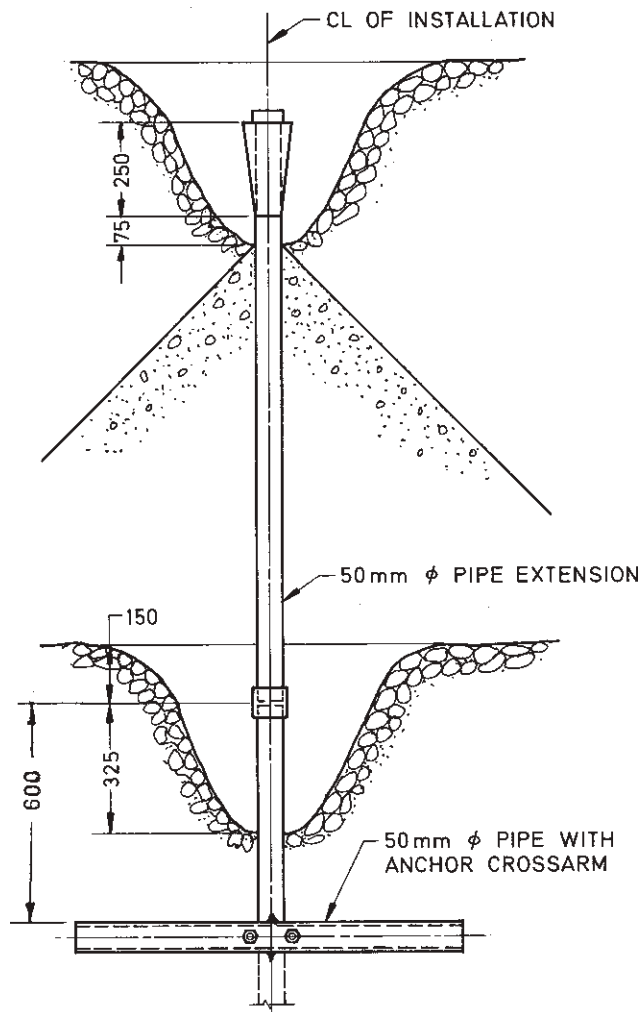
Fig. 6A Phase 1



Operations:

1. Locate centre of installation.
2. Remove soil above pipe cover; remove pipe cover from base extension.
3. Place and align baseplate unit over base extension.
4. Place a removable pipe cover at top of 40 mm pipe.
5. Wrap with oakum and burlap at joints of the 40 mm pipe with base extension (A); backfill up to 250 mm above centre line of baseplate.
6. Remove pipe cover at top of 40 mm pipe and obtain original elevation of the baseplate measuring point using torpedo.
7. Place and align 50 mm extension pipe with anchor crossarm over baseplate unit; Place a removable pipe cover at top of 50 mm pipe.
8. Wrap with oakum and burlap at joints of the 50 mm pipe with baseplate unit(B).
9. Mound rocky material around the baseplate pipe and the extension pipe with anchor crossarm, to 75 mm below the pipe cover at top.
10. Continue embankment placing to a level 150 mm above pipe cover, leaving a depression around pipe cover as shown.
11. Remove pipe cover at top of 50 mm pipe; check vertical alignment of the system by means of a plumb bob; attempt correction of deviation, if any, from vertical.

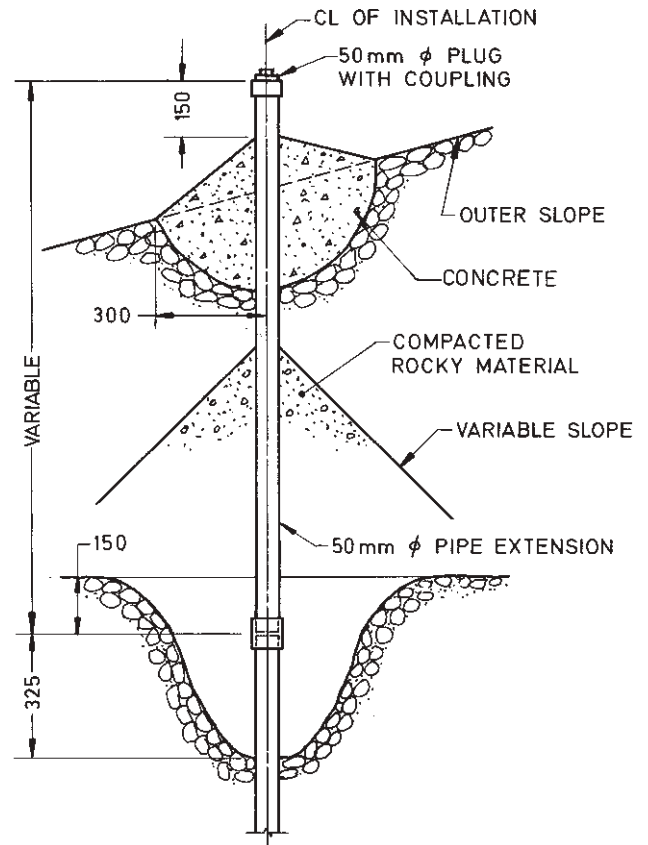
Fig. 6B Phase 2



Operations:

1. Check the centre of the installation.
2. Connect extension pipe using 50 mm ϕ pipe coupling; Seat pipe cover.
3. Mound rocky material around the extension pipe, to 75 mm below the pipe cover at top.
4. Continue embankment placing to a level 150 mm above pipe cover, leaving a depression around pipe cover as shown.
5. Repeat steps 1 to 5 till the surface of the embankment is reached.

Fig. 6C Phase 3



Operations:

1. Mound rocky material around last extension pipe; raise embankment as shown.
2. Place concrete cap.
3. Place a plug fitted to a 50 mm coupling at the top of the last extension 50 mm pipe.

Fig. 6D Phase 4

All dimensions in millimetres

FIG. 6 OPERATION OF BASE PLATE INSTALLATION IN ROCKY MATERIAL

ANNEX A*(Clause 5.2)***PROFORMA FOR RECORD OF OBSERVATION OF BASEPLATE INSTALLATION (FOUNDATION SETTLEMENT READINGS)**

Project..... Dam.....
 Location..... Top of dam.....
 Reference drawing..... Reservoir water level R.L.....
 Date of observation.....
 Observed by.....

Baseplate no.	Location Station Offset ¹⁾	Elevation of Baseplate ²⁾ Original Present	Settlement of Baseplate	Present Elevation of Embankment ³⁾	Height of Embankment Original Present ⁵⁾	Change in Depth ⁶⁾	Elevation of Water in System
6 4 4 7 4 8		6 4 4 7 4 8			6 4 4 7 4 8		

¹⁾ Record upstream of downstream from centre line of crest of dam.

²⁾ Report data to 5 mm.

³⁾ On completion of installations, use elevation of top of pipe(at system) in lieu of current elevation of embankment.

⁴⁾ Determined when the installation is complete; subtract existing elevation of baseplate from elevation of top of pipe.

⁵⁾ Indicate increase in depth by minus(-).

⁶⁾ Subtract current elevation of baseplate from current elevation of top of pipe.

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